Generation E (E – Propulsion)
Aus Sicht eines PPS Herstellers

September 2018

Color & Comfort

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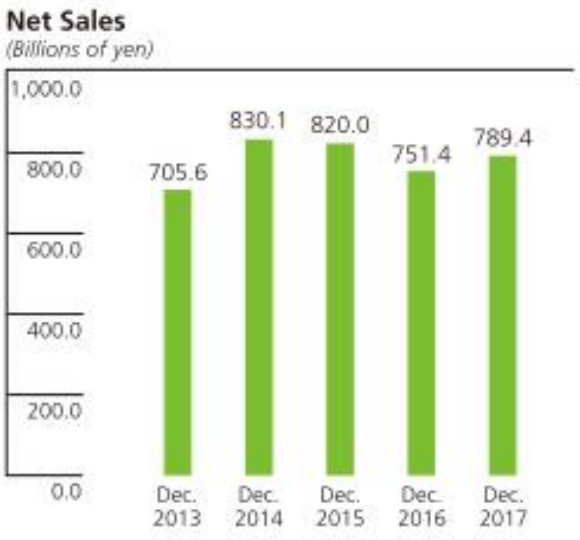
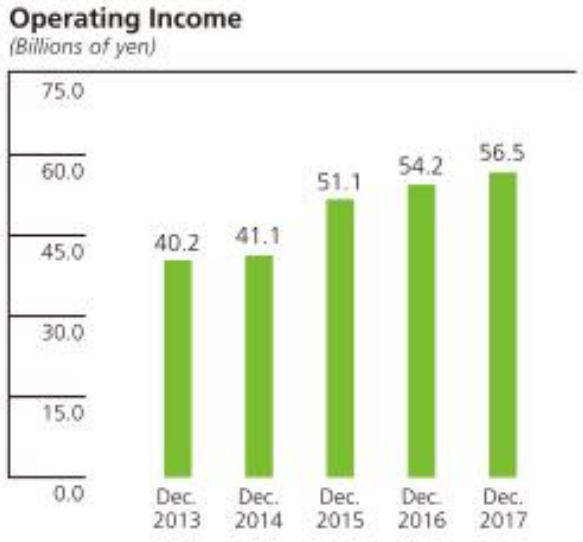
DIC Corporate Profile

Company Name	DIC Corporation
Corporate Headquarters	DIC Building, 7-20, Nihonbashi 3-chome, Chuo-ku, Tokyo, Japan
Date of Foundation	February 15, 1908
Paid-in Capital	¥96.6 billion
Number of Employees	Consolidated: 20,628 (As of December 31, 2017)
Number of Group Companies	144 (As of December 31, 2017)
Consolidated Net Sales	\789.4 billion (Fiscal year 2017)
Consolidated Operating Income	\56.5 billion (Fiscal year 2017)





Principal Business Segments

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Printing Inks Product Div.
Offset inks,
Gravure inks,
News inks, etc.

Pigment Product Div.
Organic pigments, etc.

Liquid Crystal Materials Product Div.
TFT LC materials, etc.

Polymers Product Div.
Acrylic resins,
Polyurethane resins,
UV-curable resins, etc.

Liquid Compounds Product Div.
Jet inks, etc.

Solid Compounds Product Div.
PPS compounds, etc.

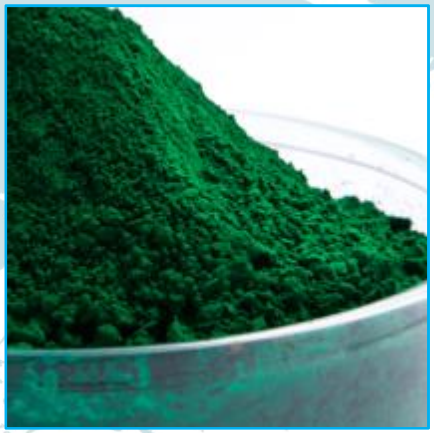
Application Materials Product Div.
Industrial adhesive tapes,
Hollow-fiber membrane modules,
Health foods, etc.

Top Share of Key Global Markets

DIC's printing inks, organic pigments, PPS compounds and other products are used in a wide range of industries in markets around the world.

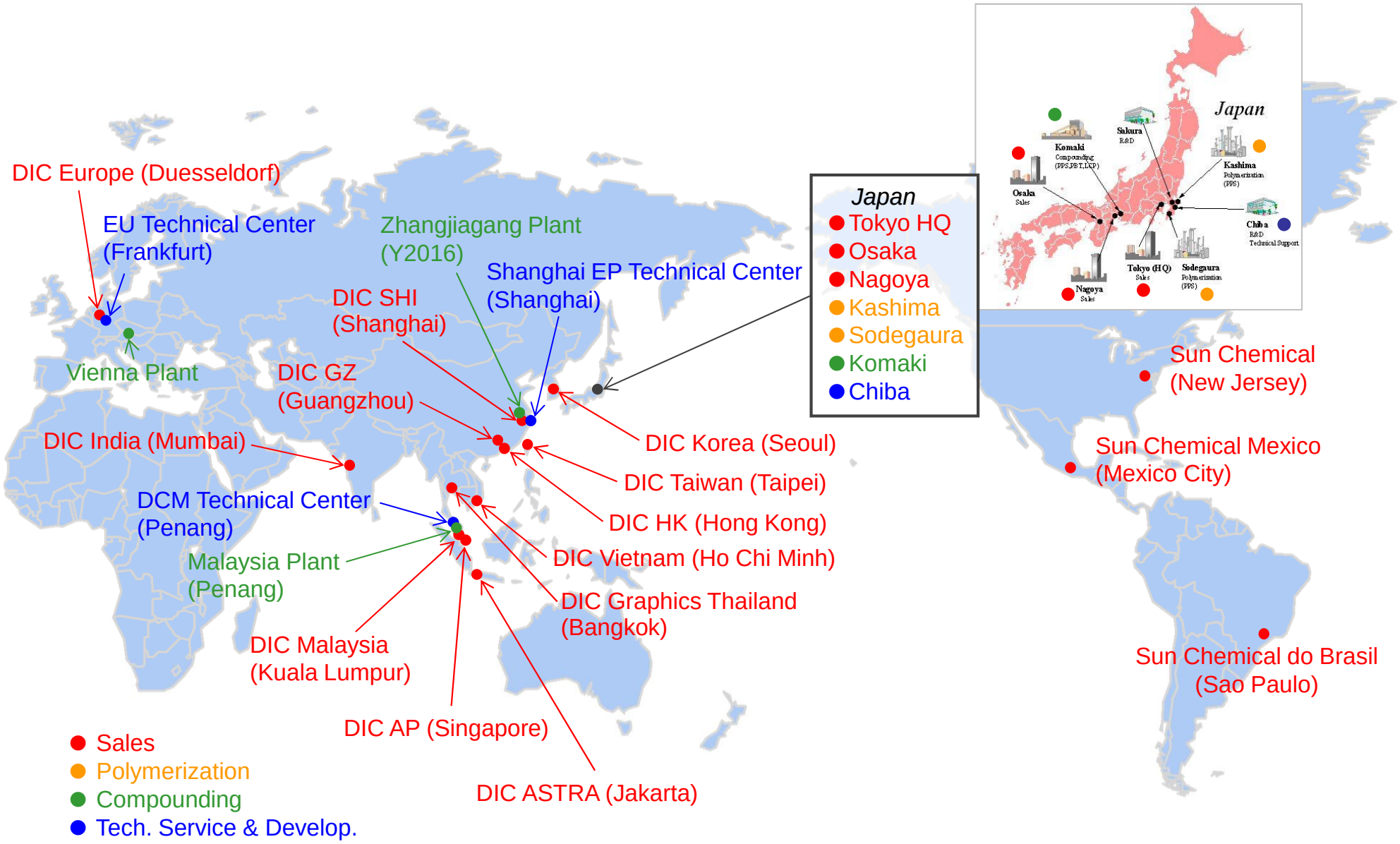
Printing inks

Organic pigments

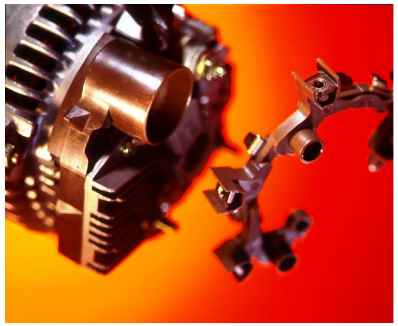


PPS Compounds

DIC.PPS Global Network

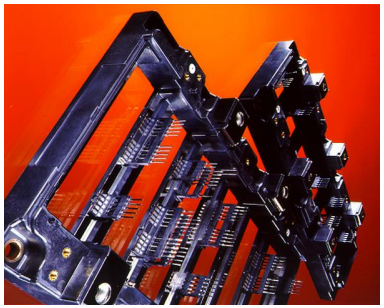


Automotive Applications, Overview



Alternator Parts

- IC regulator & rectifier
- GF40 & High Filler grades
- Heat & chemical resistances, High strength & modulus, Creep resistance, Electric insulation



Intelligent Power Module

- Power controller of hybrid car
- High Filler grades
- Heat resistance, High modulus, Low warp, Electric insulation

Electronic Sensor

- Pressure, position, velocity and temperature sensors
- Super Tough grade
- Heat & chemical resistances, Toughness

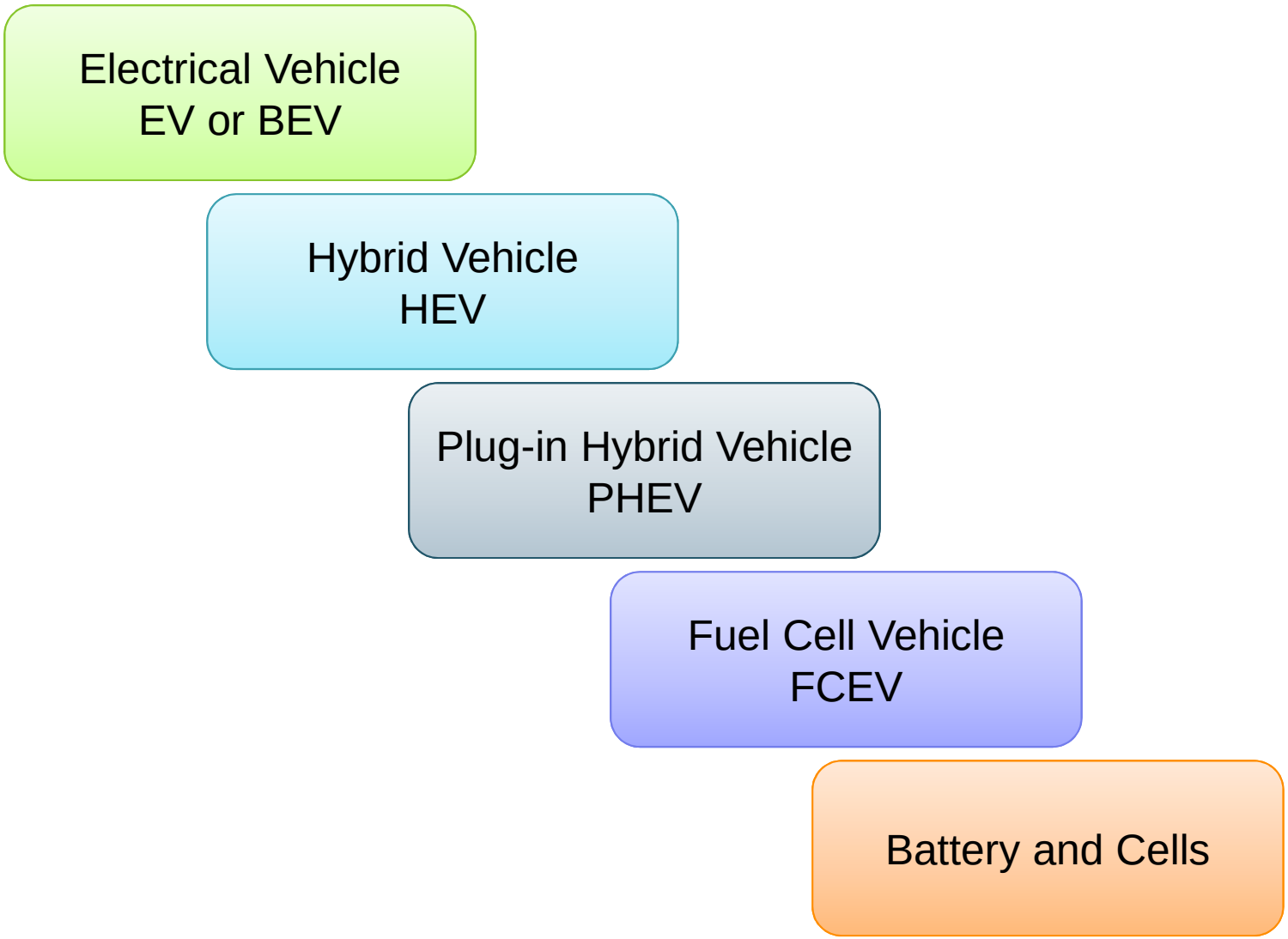
Pencil Type Coil

- Distributor-less ignition coil
- Super Tough grade
- Heat resistance, Electric insulation, Thin wall flowability, Toughness, Adhesive bonding to epoxy resin

Overview

- Definition Generation E / E- Propulsion
- The Eight Whys for Generation E
- Battery and Cells
- Existing Applications
- Appendix

Generation E / E - Propulsion



The Eight Whys for Generation E

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CO_2 Global Legislation

q Global CO_2 Legislation

- o **EU:** 95 g/km (legal requirement by 2021) è 78 g/km (draft for 2025)
- o **USA:** 121 g/km by 2020 and 95 g/km by 2025
- o **CN:** 117 g/km by 2020 and required minimum sales share of EV as of 2019
- o **JPN:** 114 g/km by 2020 (front-runner HEV)

q Local Emission Restrictions (NO_x and Fine Dust)

- o City of London – high inner city toll
- o Hamburg, Brussels, Amsterdam – city entry restrictions

q Change of OEMs‘ Vision and Mission

- o German car makers anounced a change in propulsion strategy in favor of EV due to
  - § the coming CO_2 target with its horrable penalty payments (95 Euro/g CO_2 off limit/sold car)
  - § last but not least due to „Dieselgate“ and
  - § therefore the loss of credibility in the public
- o GM, Ford, Volvo, Jaguar have launched (new) EV developments to follow the markets leaders Renault-Nissan, Tesla and BMW i
- o Car makers don‘t have any alternative to e-propulsion anymore
- o Alternative fuels are not accepted (e.g. CNG) or still too expansive (Power-to-gas, E-fuels)

Power-to-X Examples

Emission Comparison

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The Eight Whys for Generation E

q Demand

EV and PHEV Sales

EV and PHEV Production

Generation E vs. Combustion Engines

- o Slightly increasing demand observable at present
- o BMW 2017 EV and PHEV sales = 100,000 cars
- o Tesla has 500,000 orders on hand (but severe production problems)
- o EV Volumes reports an EV + PHEV sales in 2017 of 1.28 million cars
- o Analysts expect exponential growth rate as of 2022/25

q Model Portfolio

- o Currently available EVs are limited either to compact class (Renault Zoe, Nissan Leaf, BMW i3, Smart) or sport and luxery models (Tesla S, BMW i8)
- o Number of attractive models will increase significantly within the next year
  - § GM: 20 new EV models until 2023
  - § Mercedes: 20 EV models until 2022
  - § VW group: +30 EV models until 2025

q Costs

- o EV costs are expected to be comparable to combustion engine cars by 2025
- o Total costs of ownership TCO (e-car cost, energy, maintenance, tax) can meet traditional car costs eventually by end of this decade

The Eight Whys for Generation E

- **Electrical Power Grid and Battery Capacity**
  - Increasing battery capacity will extend the feasible milage/range
  - E-cars will be mainly charged at home (over night)
  - Currently the number of public charging points increases faster than the number of e-cars
  - Electrical public charging is expected
    - to be as fast as refueling today
    - to be more convenient than gas refueling in terms of cleanliness
    - to have smarter and connected payment procedures

- **Driving Pleasure**
  - High torque at as of 1 rpm guarantees fulminant acceleration
  - No noise – relaxing, pleasant environment
  - No local emissions – „green feeling“
  - No gear box – easy driving

Cons

Concern	Reaction / Outlook
Costs of EVs too high	Claim to be comparable to combustion engines as of 2022/2025
Cruising range too low	Claim to be comparable to combustion engines as of 2022/2025
EV „zero CO_2“ locally but not globally	Ignored by legislation. Test procedures set electrical energy to „zero CO_2“
Total CO_2 emission (production and service life) of EVs aren‘t (much) lower compared to combustion engines	Ignored by legislation. Only CO_2 emission during service life counts
Current power grid cannot feed the necessary number of charging points	Last mile will be critical
Huge investment in E-charging points might prohibit the progress of FCEV/H-stations	EU **è** BEV and PHEV (?) JP **è** FCEV (?)

CO_2 footprint

Batteries and Cells

- **Cells**
  - No Li-ion cell production in Europe yet (Daimler stopped 2015)
  - Key component of an EV (see below added value)
  - Production is mainly in Asia (Japan, Korea and China)
  - Asia is continously extending its production know-how
  - Europe is hanging back approx. 10 years
  - Bosch has recently decided against an investment for cell production
  - High electricity costs prohobit production in Germany
  - Asian players will build plants in Europe (Samsung SDI-Hungary, LG Chem-Poland)
  - Terra E announced „foundry“ type Li-ion cell production in Germany
  - Terra E founders are BMZ and two private persons (target 34 GWh by 2028)
  - BMZ is Europe‘s biggest Li-Ion battery producer and based in Karlstein (!)
- **Batteries**
  - Production in Europe, e.g. Daimler plant in Kamenz (w/ cells from LG)
  - VW announced double-digit billion Euro invest for 150 GWh/year capacity until 2030
  - Nissan has recently sold its UK battery production to investors
- **Added Value**
  - Battery stands for 30% to 40% of the total added value of an EV
  - Thereof the cells‘ share is 60% to 70%

Existing PPS Applications

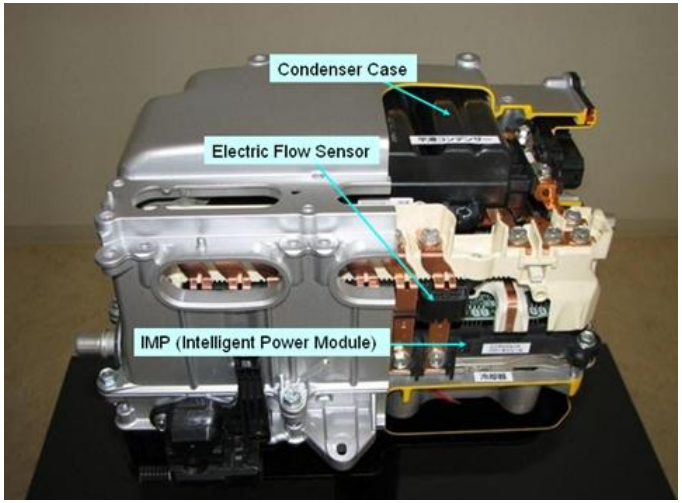
Toyota Prius

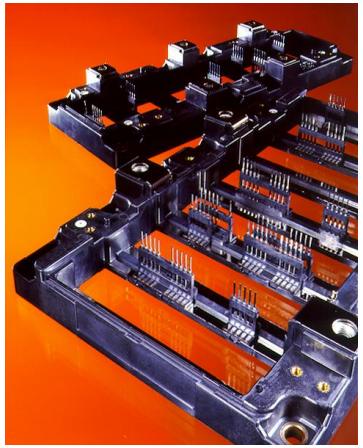
PPS volume in HV System = 1,800 g

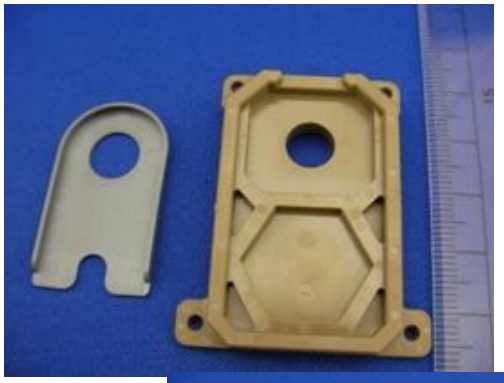
① Thermo-Inlet for Engine and HV cooling system (Z-650-T6, 160 g)
Electric Water Pump Body
② Intelligent Power Module (Z-650-S1, 500g)
Electric Flow Sensor （Z-650-B2, 60g)
Film Condenser Body
③ Generator Motor Insulator （Z-650-B2, 180g)
④ Drive Motor Insulator
⑤ Battery (Now NiMH type → Li-ion type: Gasket, Holder)

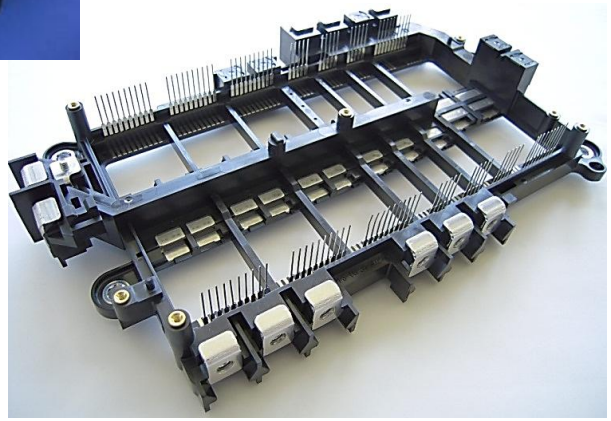
Unit	PPS Part	Grade	Requirements
IPM (Intelligent Power Module)	Housing	FZ-3600-B5 Z-650-S1	Heat shock -40 °C ↔ 140 °C Excellent flowability, Adhesion to silicone
	Outer case	Z-550	Heat shock -40 °C ↔ 140 °C Low warpage
	Outer Case	FZ-3600-M1	Low warpage Adhesion to silicon
Capacitor	Outer case	FZ-840-D1	Heat shock -40 °C ↔ 150 °C Adhesion to epoxy, Low water permeation
Motor	Coil Bobbin	Z-650-B2	Heat shock -40 °C ↔ 150 °C Good flowability
	Coil Bobbin	FZ-2140-B2	Heat resistance Good flowability
	Coil Bobbin	TZ-2010-A1	Good thermal conductivity (1 w/mk) Good flowability
Curent Sensor	Outer case	Z-650-B2	Low water absorption
Reactor	Coil Bobbin	Z-650-S1	Heat shock -40 °C ↔ 150 °C Good flowability
Li ion Battery	Gasket	Z-200-E5	Long term sealing, Electrolyte resistance Creep resistance
DC-DC converter	Outer case	Z-650-S1	Heat shock -40 °C ↔ 150 °C Good flowability
ECU	Outer case	FZ-3600-D5 FZ-2140-B2	Ahesion to silicone

Existing PPS Applications









Appendix

- EV and PHEV Sales
- EV and PHEV Production
- Outlook Generation E vs. Combustion Engines
- CO_2 - Global Legislation Passenger Vehicles
- CO_2 - Power-to-X Examples
- CO_2 - Emission Comparison
- CO_2 – Total Footprint
- New Players

Market Share EV and PHEV

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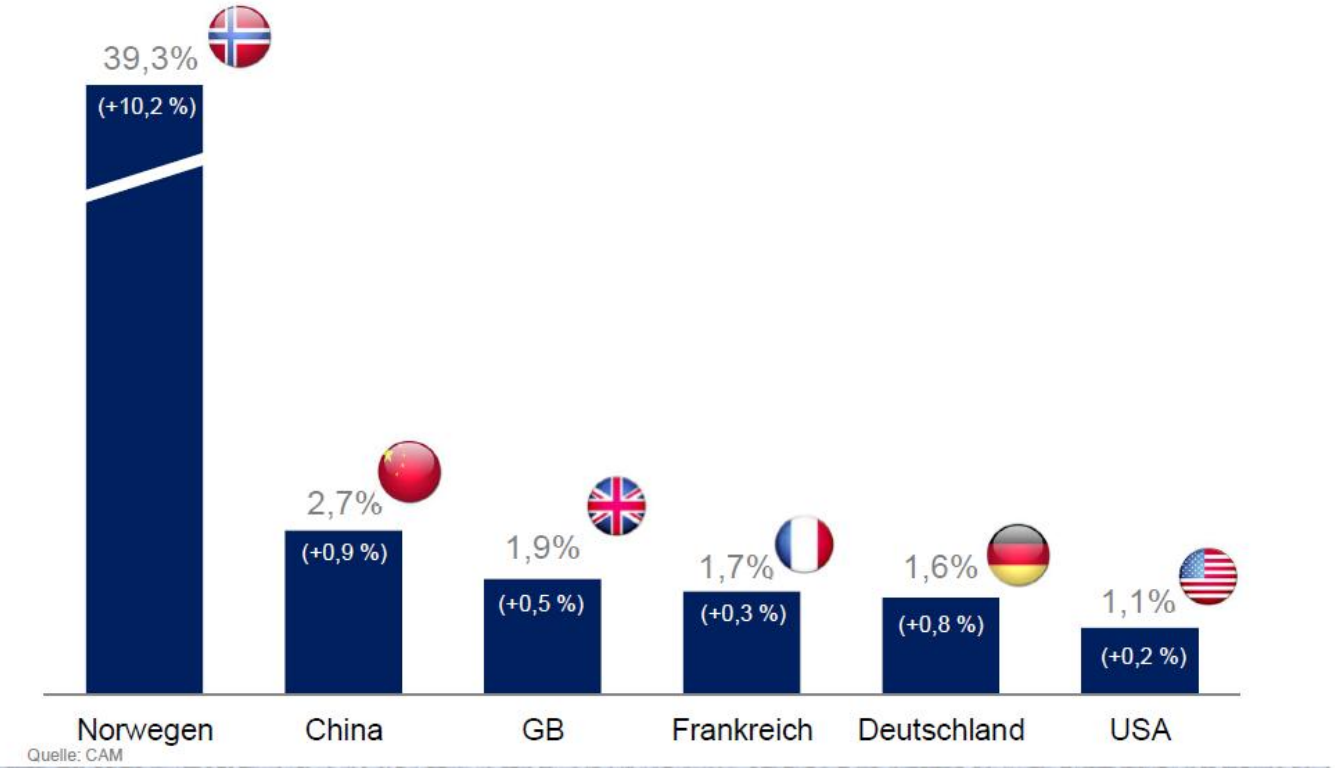
TecPart GKV Verband Technische Kunststoff-Produkte e.V.

Marktanteile Elektroautos 2017
(reine Stromer, Plug-in-Hybride)



Quelle: CAM

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EV and PHEV Sales

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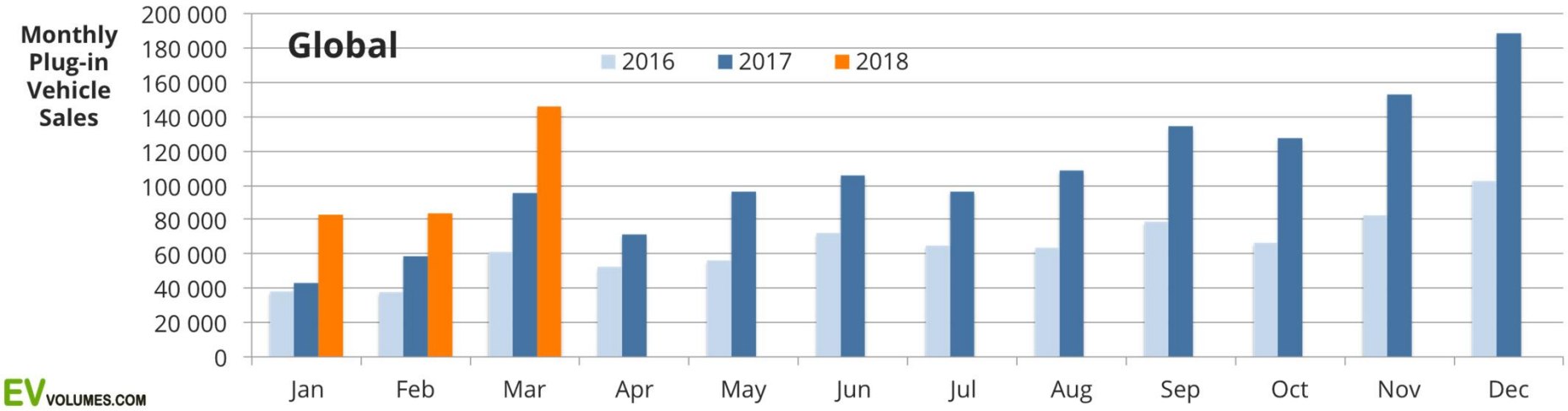

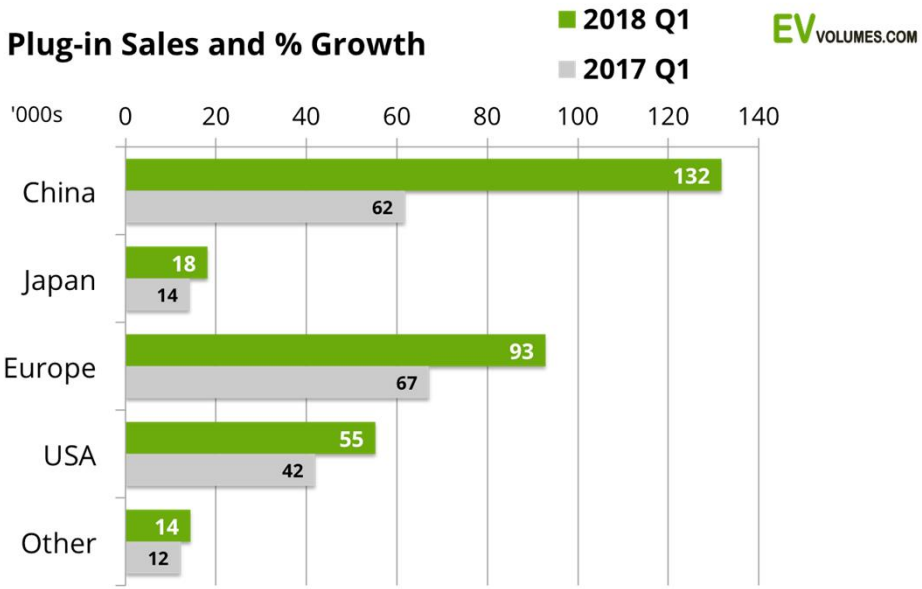

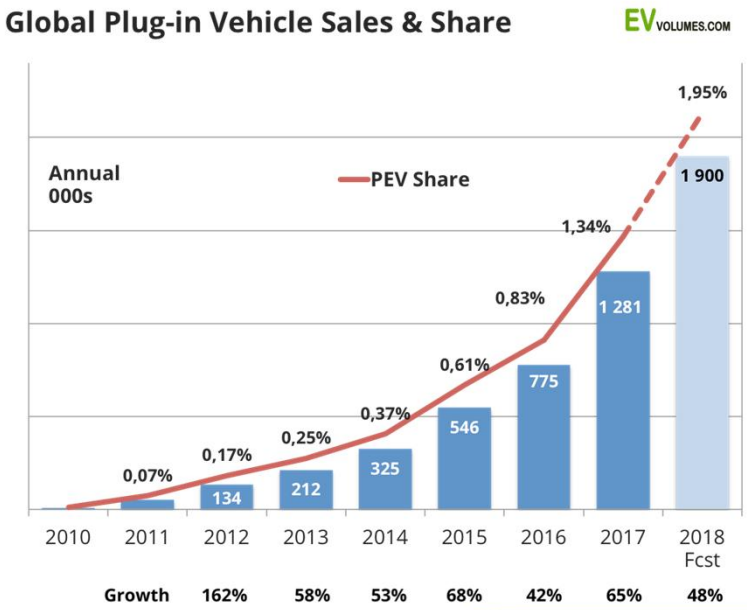

EV and PHEV Production

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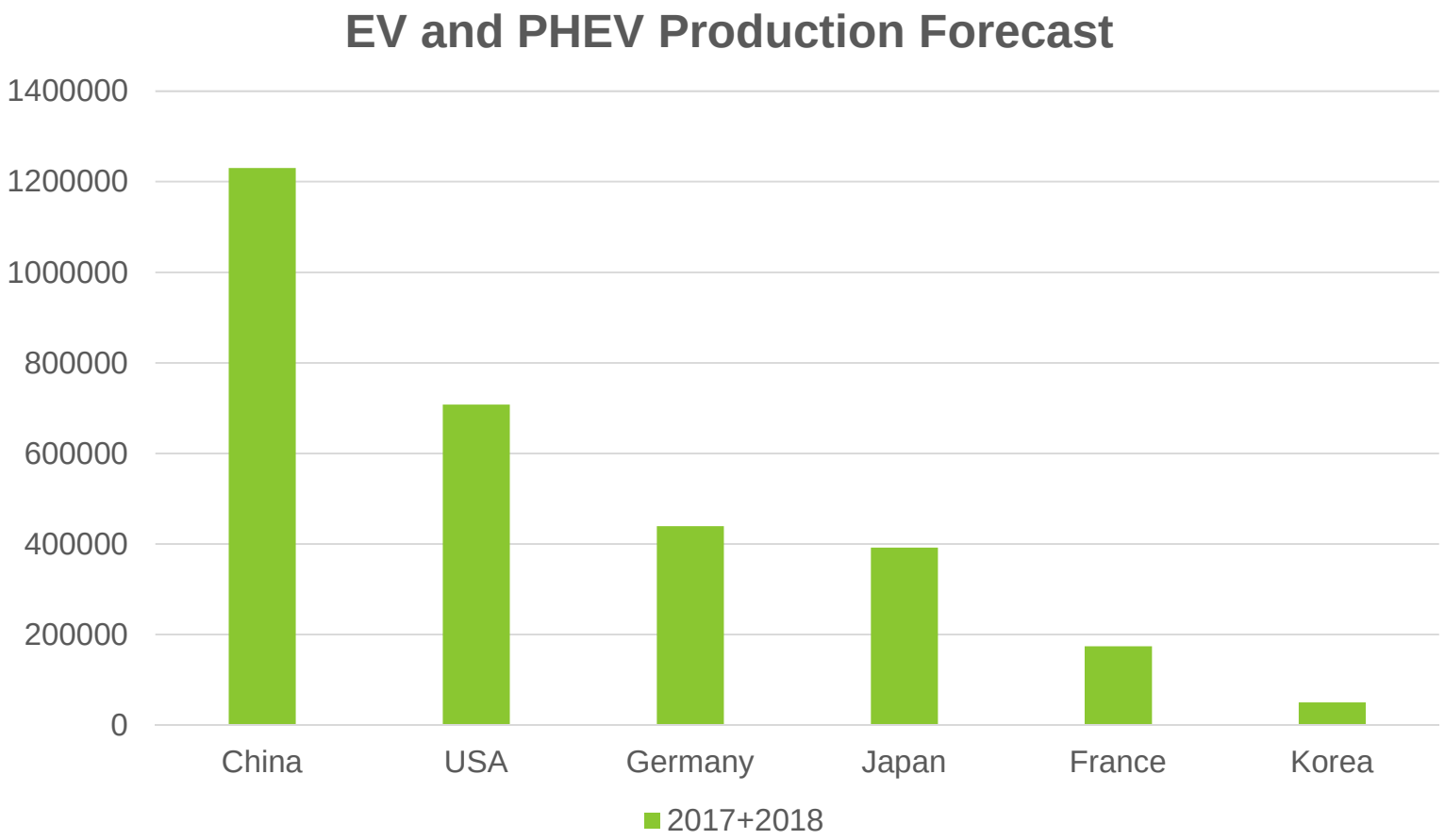

Sources: fka, Aachen
Roland Berger, Germany

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Outlook Generation E vs. Combustion Engines

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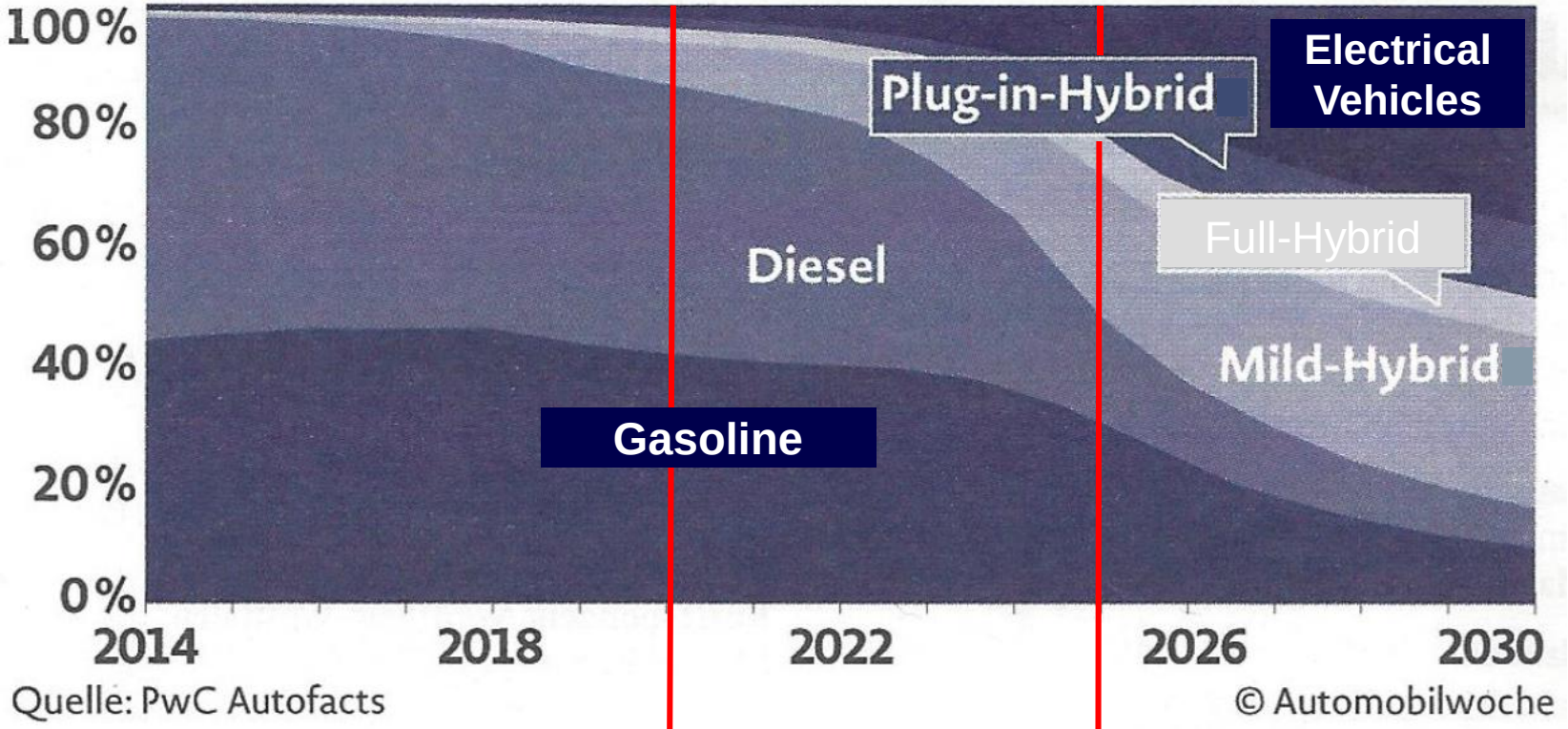
Europe, North America and China: Cars and Light Trucks



Until 2020: Decrease of Diesel mainly in favor of (Mild-) Hybrids
No significant number of Electrical Vehicles

As of 2025: Industry dynamics (cost down) accelerates sales of Electrical Vehicles significantly, S-curve progress expected
Majority of Diesel and Gas engines hybridized

- Global Legislation Passenger Vehicles

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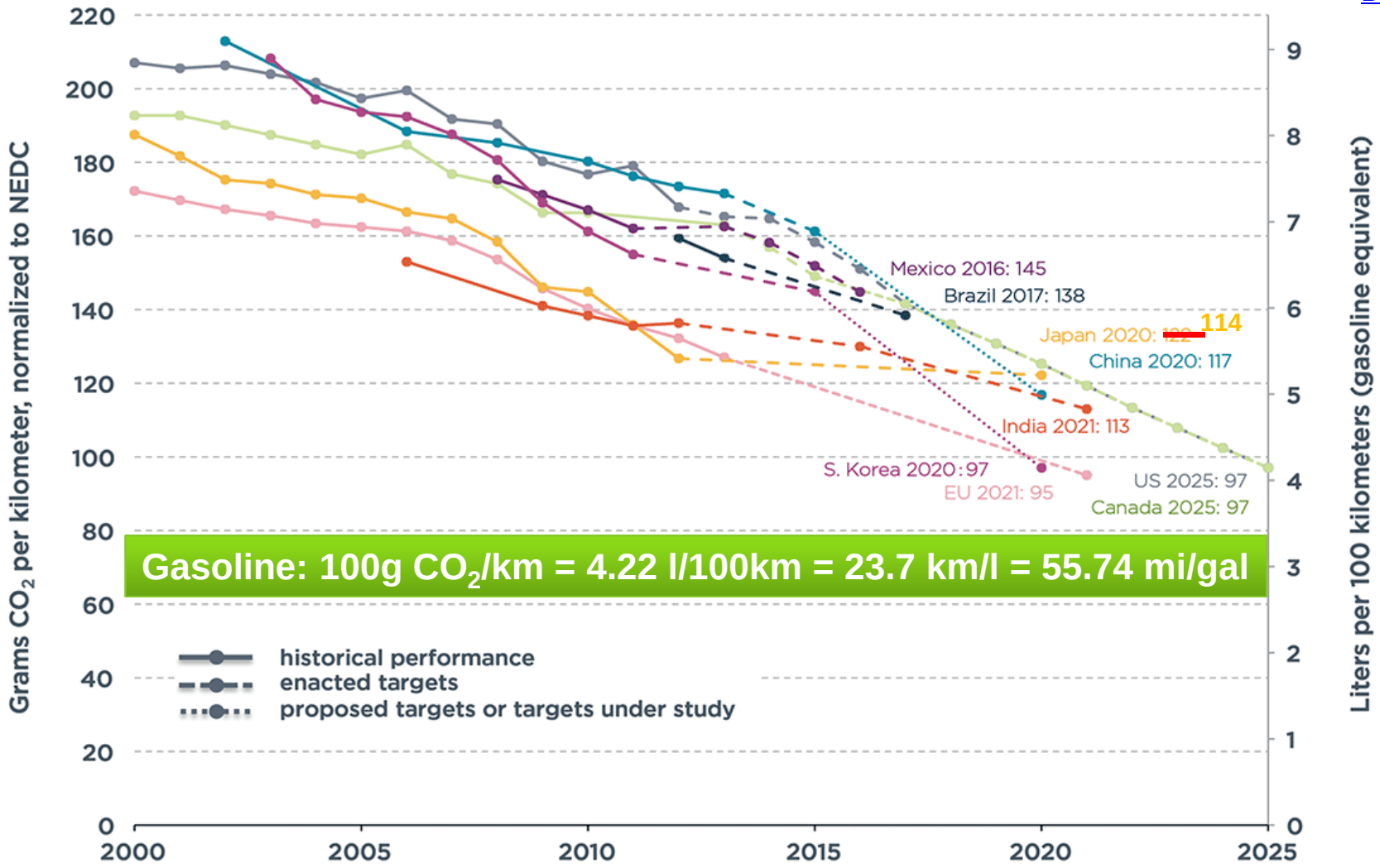

Source: ICCT
December 2014

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- Power-to-X Examples

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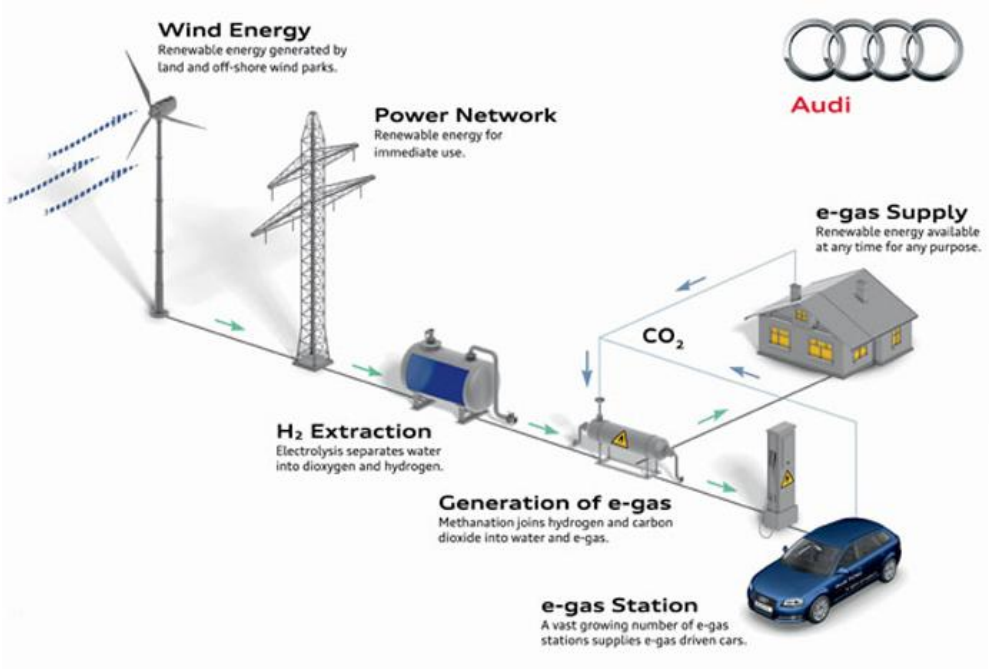

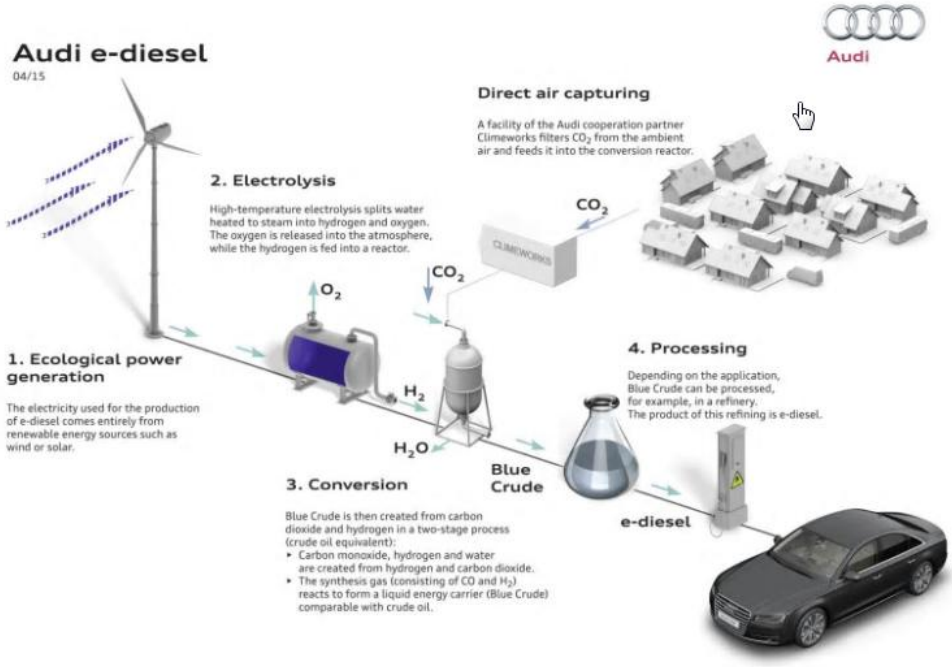

Source: Audi

- Emission Comparison

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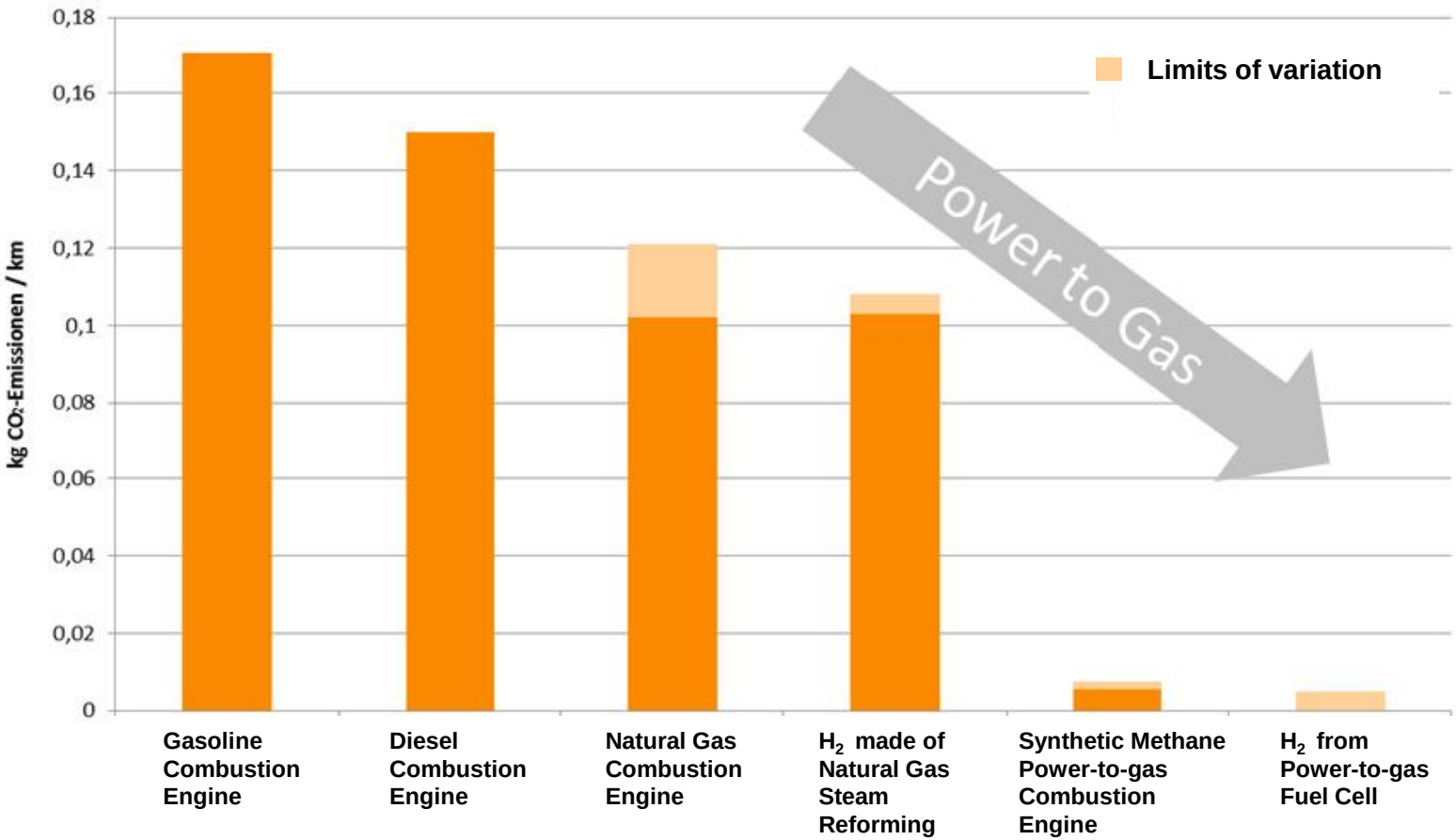
Specific CO_2-Emissions Well-to-Wheel Passenger Vehicles Germany 2014



Source: Deutsche Energie-Agentur

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- Total Footprint Production + Service Life

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Compact car – 120,000 km – 70% urban traffic

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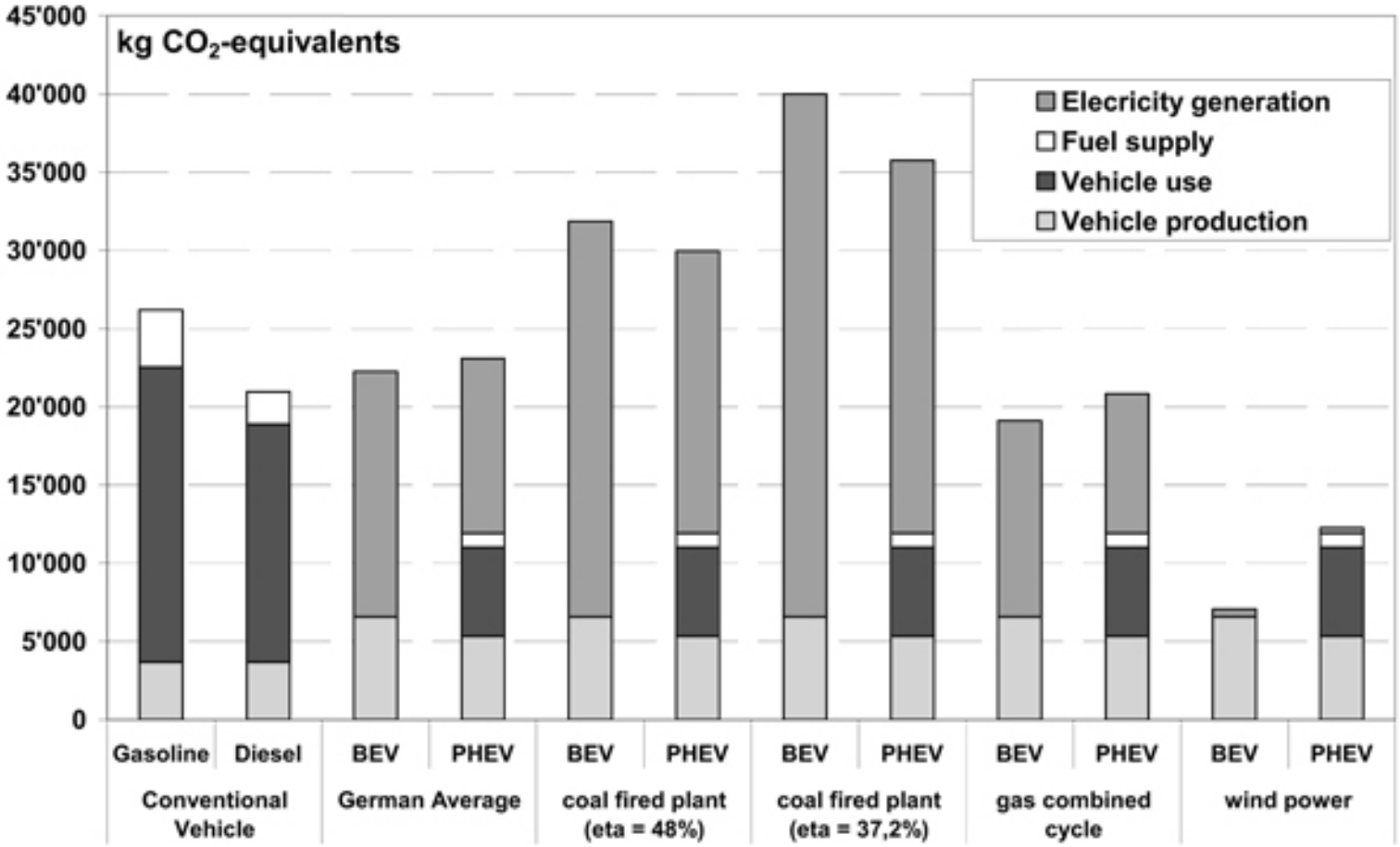

Source: Utopia, IFEU

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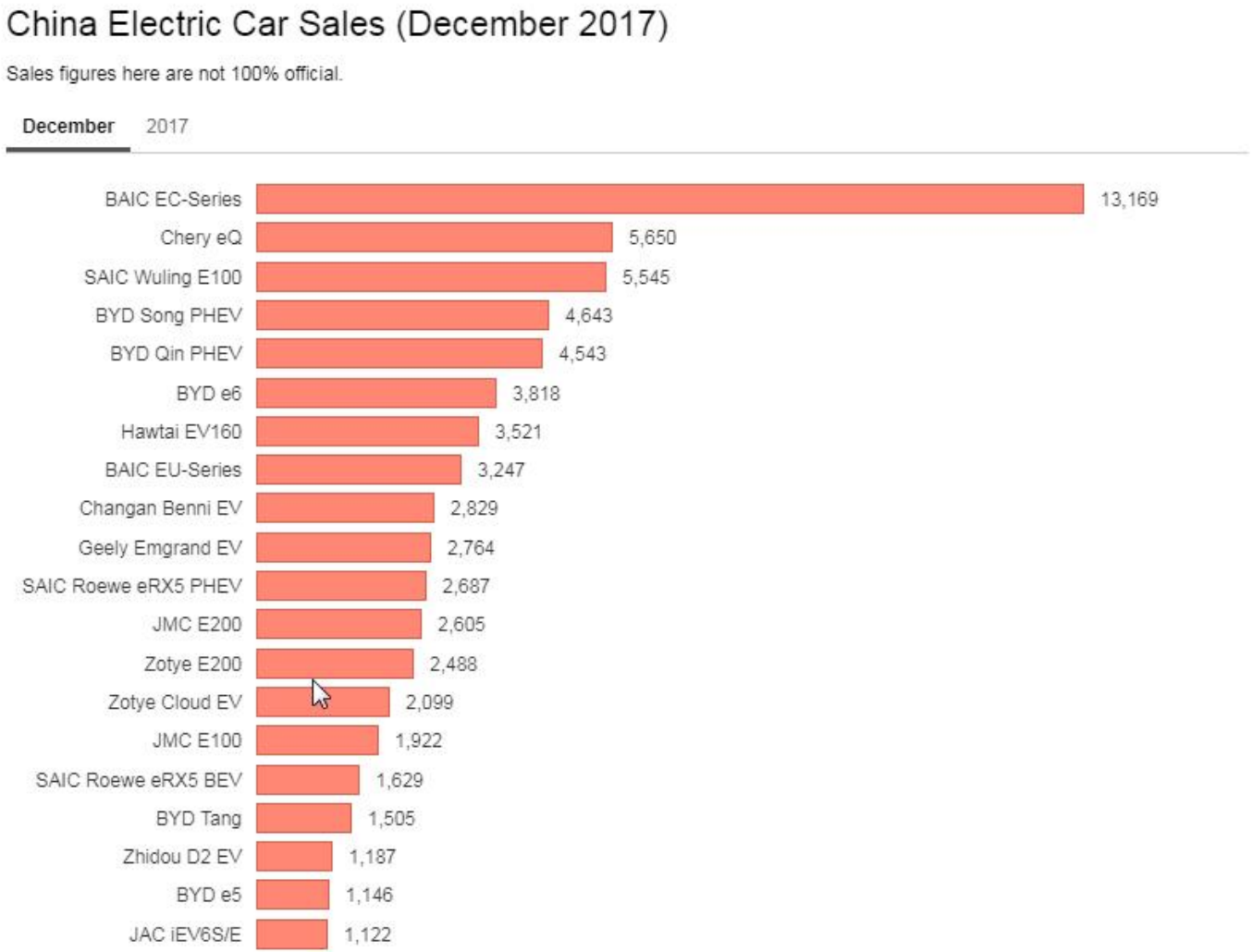
New players

China Electric Car Sales
December 2017



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Outlook

- Traditional applications will stay stable until 2025.
- Changes will come definitely, but offer also new opportunities.
- Further development will be linked to political decision.
- Fuel cells look at a overall perspective the only way to reduce our pollution problems.
- Impact on traditional automotive part maker will not occur in the next 7 years.
- Regardless whether predictions come true, there is always a place for HT polymers like PPS.
- Key is to be present and to participate and not to miss the train for new technology.

Thank you very much for your attention!

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